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UNCOVERING THE CH-53E DOPPLER MYTH

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Executive Summary

Title: Uncovering the CH-53E Doppler Myth

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Thesis: The CH-53E's Helicopter Night Vision System's (HNVS) doppler generated cuing ability is a valuable asset that can enhance the pilot's situational awareness and mitigate spatial disorientation in low-level maneuvers (approach, landing and takeoff) while in degraded visibility conditions. Additionally, training and employing the current doppler cuing capabilities today will aid the CH-53E community in transitioning into the future cuing systems of tomorrow.

Discussion: Since 9/11, the CH-53E community has been on an increased operational tempo in support of the ongoing operations across the globe, especially in the deserts of the Middle East and Africa. As the Corps' workhorse in providing day and night assault support in these austere locations, CH-53E pilots are frequently encountering degraded, or even worse, brownout conditions while maneuvering in low-level and low-speed regimes in support of ground forces. The increased potential for spatial disorientation or loss of situational awareness in degraded visibility conditions warrants a need for additional aircraft equipment to provide pilots with reference information to help mitigate the potential risks.

Ongoing research and development to address low visibility and brownout mitigation in the CH-53E is expected to yield a near-term solution that will use an imaged vector-based cuing system to display realtime velocity, direction, and acceleration. Pilots will be able to make aircraft adjustments, especially in zero visibility regimes, via the visual cues on their displays. The long term solution, currently being designed into the CH-53K, will be a flight system that will couple the motion information directly to the auto-pilot, thus allowing the aircraft to automatically adjust to deviations.

Today's CH-53E is currently equipped with a HNVS that includes a doppler radar also capable of providing information to display velocity, direction, and acceleration cues. Although not as precise as the near-term solution which will utilize an Embedded GPS/Inertial Navigation (EGI) system, the doppler can generate valuable motion information to assist the pilots. Unfortunately, the CH-53E community has not acknowledged this capability in its training manuals and syllabus. As a result, generations of pilots have been deprived of the ability to train and employ the aircraft's doppler asset. Furthermore, without experience in its ranks, the CH-53E community will be ill prepared to efficiently and effectively transition into the more robust cuing systems expected in the CH-53K.

Conclusion: Timely implementation of the HNVS's doppler cuing system in training and subsequently in mission operations is essential in providing today's pilots with a means to mitigate the risks of low-level flight in low and zero visibility conditions when maneuvering in austere landing zones. Additionally, with the incorporation of a new EGI cuing system on the horizon and the CH-53K in the future, the CH-53E community can eliminate "generational biases" that are certain to arise as the new technology comes online. By eliminating the CH-53E community's conscious avoidance of the HNVS's doppler capabilities, pilots will be prepared for today's and tomorrow's challenges.

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INTRODUCTION

In the early morning hours of April 25, 1980, three U.S. Marines and five U.S. Air Force airmen, lost their lives to the Iranian desert in one of the deadliest phenomena known to rotary-wing aviators. The eight service members were a part of Operation Eagle Claw that involved eight Navy RH-53D helicopters, flown by Marine pilots, to support Delta Force operators in recovering 53 Americans held hostage by militant Iranian students in Tehran, Iran. Launched from the aircraft carrier *USS Nimitz* located in the Persian Gulf, the helicopters made a planned but ultimately doomed stop at an intermediate landing field codenamed Desert One. Parked at the airfield were four Air Force C-130 Combat Talon Hercules aircraft that were prepositioned to support the mission.

At 0100, over five hours after leaving the *USS Nimitz*, only six helicopters had landed at the airfield: two turned back to the carrier for mechanical reasons.[1] The landing surprise at Desert One should have been a forecast of the catastrophe to follow. The pilots expected a hard surface, but instead the soft sand of the desert floor greeted them.[2] As one pilot described the environment:

> The dust was really thick. More than 6 inches where we were programmed to land. Our checks…had not predicted that amount of sand, due to storms. We dug in and nearly went over. I had to leap frog the aircraft. Go up for about five seconds, then come down, then back up, and down. Finally we got to a hard enough place and were near the fuel line and that was it. You couldn't ground taxi.[3]

An hour later at 0200 on April 25, the mission, requiring at least six aircraft, was aborted due to a mechanical problem of one of the RH-53Ds.[4] In the ensuing efforts to redeploy the assets out of Iran, there was a need to reposition two helicopters in order to allow room for a C-130 to taxi for departure. Tragedy struck when the first helicopter, piloted by Major Jim Schaefer USMC, lifted off to reposition. Mark Bowen illustrates the scene:

> Schafer lifted the chopper to a hover about fifteen feet and held it, kicked up an intense storm of dust that whipped around the combat controller on the ground. The combat controller was the only thing Schaefer could see below, a hazy black image in a cloud of brown, so the pilot fixed

on him as a point of reference...To escape the cloud created by Schaefer's rotors, the combat controller retreated toward the wing of the parked C-130. Concentrating on his own aircraft, Schaefer didn't notice that his blurry reference point on the ground had moved. He kept the nose of his blinded chopper pointed at the man below, and as the combat controller moved, the helicopter turned in the same direction, drifting to a point almost directly above the plane.[5]

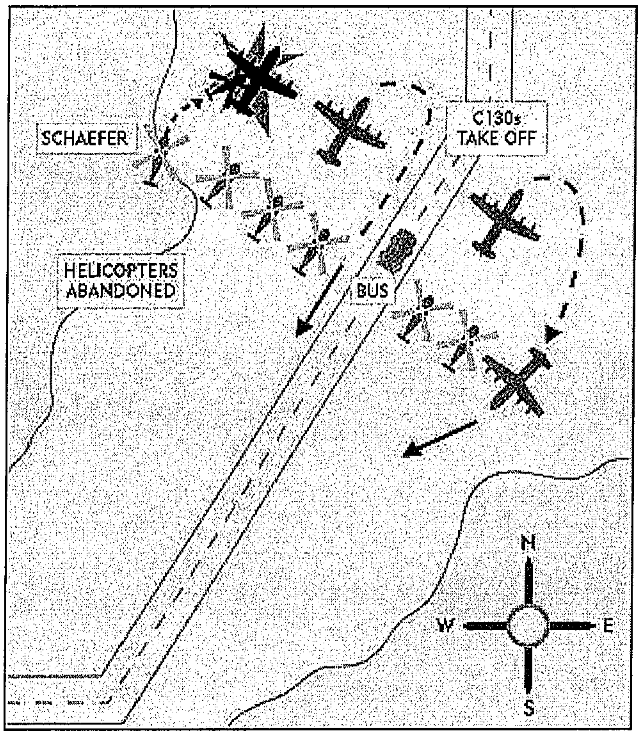


Figure 1. Desert One[6]

The drifting RH-53D collided with the C-130 (Figure 1). Both aircraft, full of fuel, exploded into a fireball ultimately killing the eight men and destroying the aircraft.

This vignette at Desert One is being played out at many forward operating bases (FOBs), airfields, and austere landing zones (LZs) across the deserts of Iraq, Afghanistan, and Africa. Although an accident of this enormity has not happened, the possibility always exists. Degraded visibility or brownout conditions are a constant threat for helicopter pilots operating in low-level regimes (approach, landing, hover, takeoff). Although intelligence reports and satellite imagery can provide approximate information on a landing zone, often the true soil composition is unknown until the pilot tries to land in it. The surprise of the RH-53D pilots upon arriving at Desert One remains intimately familiar to those flying the Marine Corps' CH-53E "Super Stallion" today.

Fortunately, the CH-53Es flown throughout the world today are more technologically advanced than the RH-53Ds were in 1981. With the addition of the Helicopter Night Vision System (HNVS) in 1995, pilots have more information available to enhance their situational awareness in degraded or zero visibility regimes.

Surprisingly, since the addition of the HNVS to the aircraft, the CH-53E community has not exploited its doppler generated cuing system as a means of assisting pilots in the low visibility environment. The absence of training and education has subsequently produced generations of pilots who lack the knowledge, appreciation, and trust of the capabilities available to them by the HNVS. As a result, when new technologies become available that will increase the fidelity and accuracy of the cuing system, CH-53E pilots will not have a sufficient baseline of experience to make an effective and efficient transition.

In an effort to address the degraded visibility and brownout issues of today and to avoid future "growing pains" and "generational users" of tomorrow's technology, the CH-53E community must aggressively address the current void in training and implementation of the current HNVS system. Therefore, this paper will examine the valuable capabilities of the CH-53E's doppler generated cuing system to enhance the pilot's situational awareness and to mitigate spatial disorientation in low-level maneuvers (approach, landing, and takeoff) while in degraded visual conditions. By analyzing the current tactics, techniques, and procedures (TTPs), both written and in practice, it will be evident how the doppler technology has been neglected, rather than embraced. In the end, by accepting and incorporating the doppler, pilots will be able to add another tool to their TTPs in order to combat the risks associated with degraded visibility flying.

THE DANGEROUS ENVIRONMENT

Degraded Visibility and Situational Awareness

In the post 9/11 era, CH-53E pilots are spending more time operating in the desert environment than their predecessors did a mere decade ago. Whether in Iraq or the Horn of Africa, today's operational tempo often requires a pilot to deploy to the same area of operations three to four times in a single tour of duty at a squadron. While "in country," pilots are not only performing their everyday tasks of moving weapons, equipment, and personnel between the many FOBs, but they are also being used to insert and extract Special Forces operators and quick reaction units in austere locations. Regardless of landing zones, pilots are constantly on guard of encountering degraded visual conditions. Every so often, a mission's requirements necessitate the pilots to mitigate the risks to maneuver through these unavoidable circumstances.

Flight in degraded visual conditions is a dangerous affair. If not mitigated early with the use of the aircraft's systems, the loss of situational awareness can lead to spatial disorientation and potentially a mishap. All pilots, regardless of experience and training, are susceptible to it. Spatial disorientation, as defined by the Aircraft Owners and Pilots Association Air Safety Foundation is:

> Spatial disorientation is the mistaken perception of one's position and motion relative to the earth. Any condition that deprives the pilot of natural, visual references to maintain orientation, such as clouds, fog, haze, darkness, terrain or sky backgrounds with indistinct contrast (such as arctic whiteout or clear, moonless skies over water) can rapidly cause spatial disorientation.[7]

The threat of spatial disorientation increases especially during low altitude profiles (approach, hover, landing and takeoff) because of the reduction of recognition and reaction time due to the aircraft's proximity to the ground.

In the case of a helicopter (see Figure 2), the increased amount of loose dirt and debris that becomes airborne by the rotor downwash at low altitudes can be detrimental to the pilot's visibility.

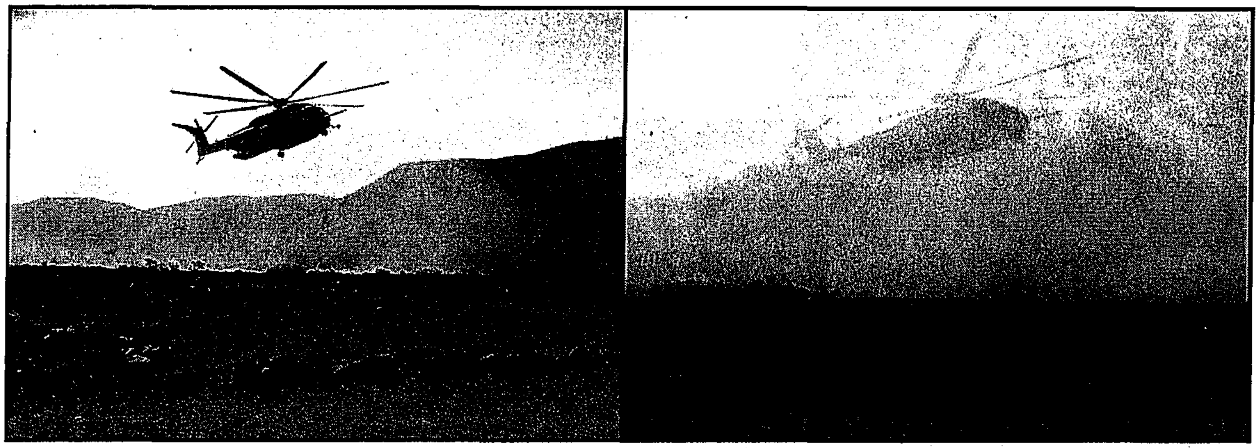


Figure 2. Rotor Downwash Effects[8]

By losing or degrading their visibility, the pilots are in danger of acquiring spatial disorientation, thus increasing their chances of a mishap. The Defense Alliance of Minnesota's response to the Air Force Research Laboratory's Notice of Urgent Warfighters Requirement describes the effects best:

> In general, however, it should be assumed that helicopters will begin to experience brownout during an angled, no-hover approach to landing at approximately 1-2 rotor diameters above ground level (50 – 150 feet), with the most serious conditions being experienced at approximately 50 feet and below. As the aircraft slows, the thrust vector of the main rotor disc becomes more vertical (as the aircraft pitches its nose up to decelerate), and the thrust becomes greater as power is added to sustain a hover, or near-hover condition prior to landing. Also, the rotor thrust tends to circulate down, out, then back up and down again through the rotor disc just prior to touchdown. Therefore, all of these conditions combine just prior to landing, the most critical time for the pilot to eliminate lateral drift.[9]

Top heavy with virtually all of the major components, such as the rotor blades, engine(s) and gearboxes, there is a danger of a rollover occurring if the pilots unknowingly attempt to land without correcting any lateral drift.

Mishap Awareness

Loss of situational awareness and spatial disorientation from low visibility or brownout conditions has contributed to countless mishaps in the armed service's rotary-wing units. From 1973 to late 2006, the Air Force estimated 21 MH-53 Pave Low and 10 HH-60G Pave Hawk helicopters were involved in mishaps in which "pilots lost visual reference due to blowing dust and debris."[10] Army statistics revealed that 12 of the 41 CH/MH-47D/E mishaps from 2002 to 2005 were due to brownouts.[11] In addition, post 9/11 statistics in the Department of the Navy attributed eight helicopter mishaps to brownout.[12]

Although there have been "significant strides in reducing the rate of helicopter losses in combat zones due to pilot error and mechanical failure," the potential for mishaps remains a major concern for the senior civilian and military leadership in the Department of Defense.[13] According to Naval Safety Center statistics, between FY 2002 and FY 2006, aircrew error has accounted for over 94 percent of the total mishaps in the Marine Corps' rotary wing aviation (see Chart 1). In Operation Iraqi and Enduring Freedom (OIF & OEF) alone, 87 percent of the mishaps were caused by pilot error (see Chart 2). In 2006, Lt. Gen. John Castellaw, then deputy commandant for aviation, reported that the Marine Corps had 23 helicopter mishaps in the post 9/11 era in the Central Command's area of responsibility, with 16 of those mishaps occurring at "times of low visibility and at night and

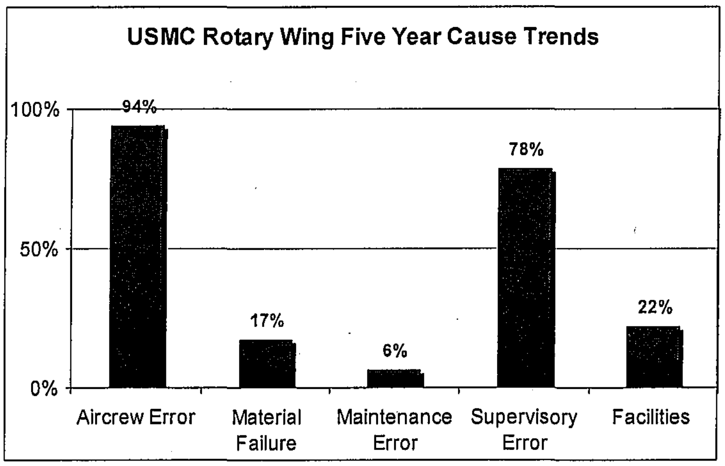


Chart 1. USMC Rotary Wing Five Year Cause Trends (FY02-FY06)[14]

brownout conditions."[15] According to Naval Safety Center statistics, since 1990, brownout conditions either directly contributed to or aggravated nine USMC rotary wing mishaps, five of which occurred after the beginning of OIF/OEF.[16] Additionally, the Naval Safety Center received three hazard reports on brownout issues for dissemination to the fleet.[17] It is therefore quite understandable why the issue of degraded visibility is of a high priority among the armed services.

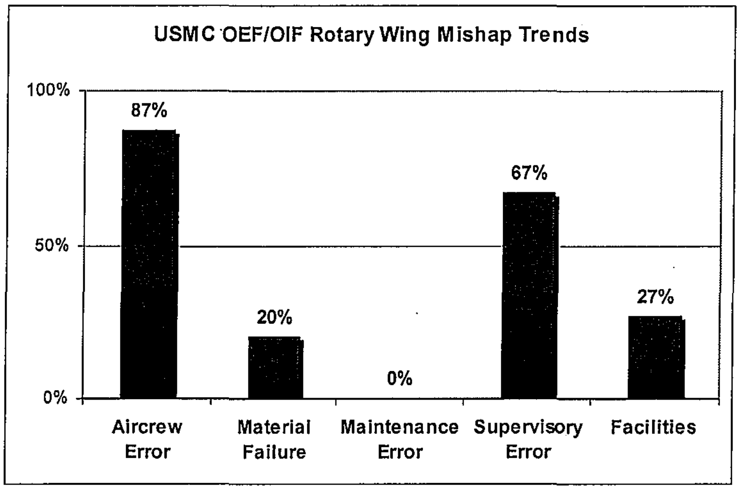


Chart 2. USMC OEF/OIF Rotary Wing Mishap Trend (FY02-FY06)[18]

The focus on the issue of degraded visibility in low-level regimes is apparent. Mishap statistics across the armed services provide a grim reminder of the dangers associated with this phenomenon. Unfortunately, these statistics only tell half the story. There are likely more "close calls" caused by degraded visibility than have been officially documented. In the end, they will remain as "war stories" to be told as lessons in ready rooms across the fleet.

THE AIRCRAFT

The Corps' Changing Super Stallion

Designed to support the MAGTF commander with assault support transport of heavy equipment, combat troops, and supplies, day or night under all weather conditions, the Marine Heavy Helicopter squadron's (HMH) mission has been crucial to the Marine Corps' success at home and abroad.[19] The mainstay of the HMH community is the Sikorsky CH-53E Super Stallion, a descendant of the CH-53A Sea Stallion, which first saw combat action on 25 January 1967 during the Vietnam War.[20] Still flown today are numerous variants, such as the U.S. Air Force's special operations MH-53J/M Pave Low and the U.S. Navy's minesweeping MH-53E Sea Dragon.

The CH-53E entered service in December 1980, and twenty-three years later on November 24, 2003, the production line closed with the last delivery of the 172nd airframe. Over its 27-year span, the CH-53E's has flown in every "clime and place," with recent notable successes such as the rescue of downed Air Force pilot Captain Scott O'Grady in Bosnia and the long range airfield seizure at Kandahar in the opening operations with Task Force 58 in Afghanistan. Unfortunately, training and combat operations have taken a toll on the inventory. Unexpected attrition due to mishaps has reduced the CH-53E community. As of this writing only 149 aircraft remain.[21]

Continuously transforming through modifications and upgrades, the CH-53E flown today is very different from the first ones that came off Sikorsky's production line in December 1980. Two such upgrades that have enhanced the capabilities of the aircraft are the Helicopter Night Vision System (HNVS) and the AN/AVS-7 Heads-Up Display (HUD). By providing critical aircraft information, these systems have aided many pilots in mitigating some of the risks of flying at night and in low visibility environments.

Helicopter Night Vision System (HNVS)

The HNVS, initially incorporated in 1995 included the installation of three key pieces of equipment, the AN/AAQ-16 Forward Looking Infrared (FLIR) sensor, AN/APN-217(V)3 Radar Navigation Set (doppler), and two panel mounted displays (PMD). Combined, the equipment supplies the pilots with additional aircraft information that is not otherwise available when visibility is limited or obscured. Utilizing the HNVS capability, pilots are not only able to supplement their visual scan with the infrared technology, but more importantly, the cues produced by its doppler system can provide them with a concrete picture of the aircraft's disposition.

The AN/AAQ-16 (-29, -29A) series are navigational FLIRs that produce a thermal picture of the outside world to aid in navigation and flight at night.[22] The forward-looking sensor collects the radiated infrared (thermal) energy of the environment, converts it to a viewable image, and then displays it on the PMD for the pilots. Since objects retain and radiate distinctive levels of heat, the contrast of heat signatures generates the distinct scene pictured on the PMD. Fortunately, since the FLIR works with thermal levels rather than from ambient light, unlike the night vision goggles (NVG), it can be used during the daytime as well.

The Infamous Doppler

The AN/APN-217(V)3 Radar Navigation Set (Doppler) was included in the incorporation of the HNVS upgrade. As defined by the CH-53E NATOPS manual, the doppler:

> provides helicopter ground speed; drift angle; and horizontal, vertical, and lateral velocity information. It is a self-contained surface velocity sensor that uses continuous wave radar energy to automatically measure the heading, drift, and vertical velocity of the helicopter motion. From these measurements, the heading, drift, and velocity of the helicopter are calculated and displayed on the panel display units.[23]

In essence, the sensor continuously measure the rate-of-change in frequency, or doppler shift, of the transmitted energy as it returns to the receiver. Similar to the "radar guns" used by police officers to

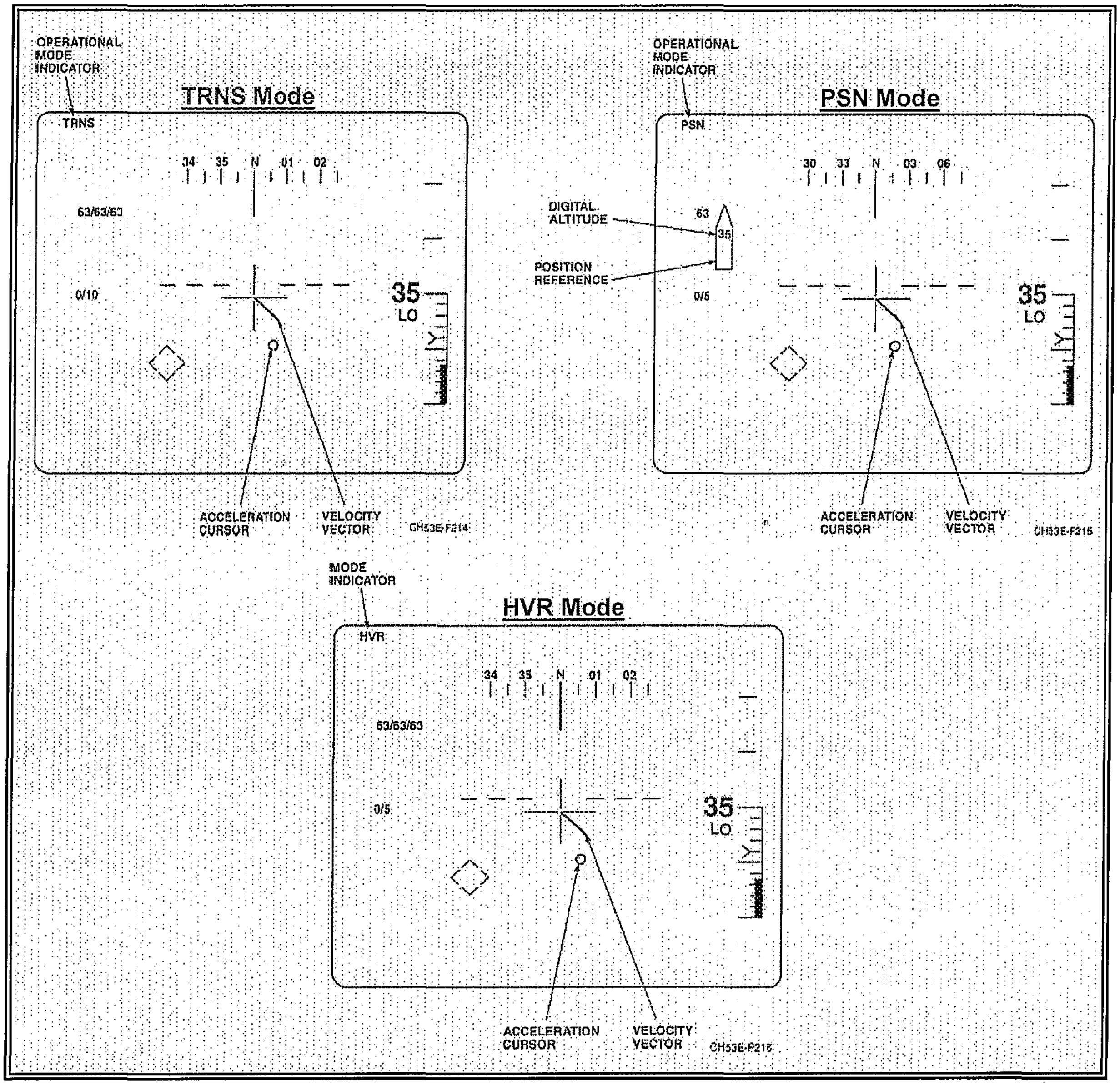


Figure 3. TRNS, PSN, HVR HNVS Pages[24]

catch speeders, the doppler captures velocity and direction measurements to determine the aircraft's movement. The HNVS's signal data converter then generates the data used to create the flight and navigation symbology displayed on the pilot's PMD and HUD.

Five operational flight modes are available to the pilots, three of which are specific to this research (see Figure 3). The primary employment of the TRNS (transition), HVR (hover), and PSN (position) pages are specific to the terminal regimes of flight— approach, landing, and takeoff. They share similar symbology (PSN adds a position reference box), but when selected the individual pages adjust to reflect information proportional to the flight regime of the aircraft. Essentially, the symbols (velocity vector and acceleration cue) return a visual image representing the appropriate velocities relative to the aircraft: TRNS (at or below 60 KIG), HVR & PSN (at or below 5 KIG). A single vector symbolizes the longitudinal (forward or aft) and lateral (left or

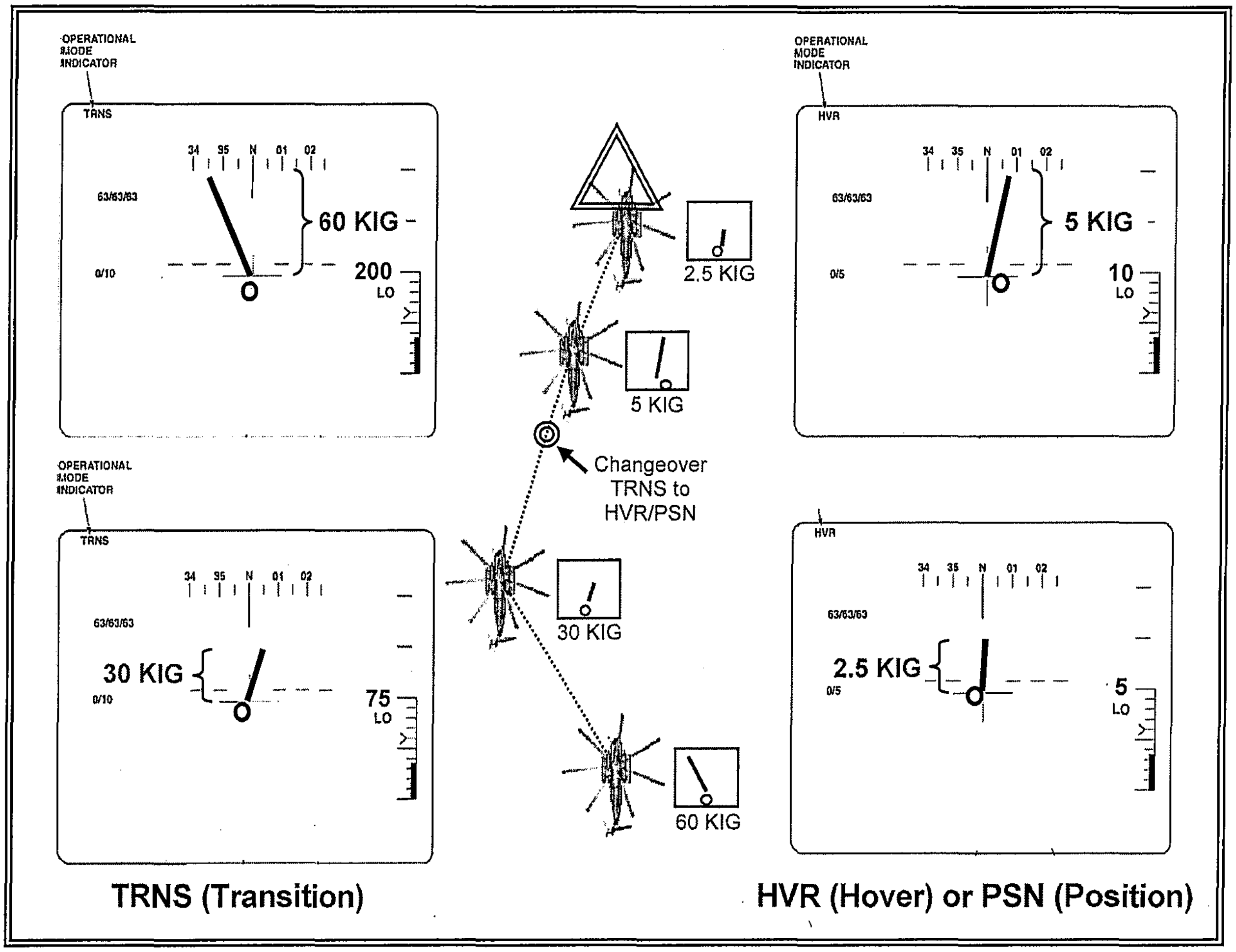


Figure 4. Airspeed Proportionality: Velocity Vector & Acceleration Cue[25]

right) movement of the aircraft with the length representing the velocity at which the aircraft is moving (see Figure 4). By selecting a specific page on the PMD, the pilots automatically scale the vector to represent the regime of the aircraft. Finally, an acceleration cue represents the acceleration of the aircraft in the direction of symbol. The distance away from the center is directly proportional to the speed at which the acceleration is occurring.

These tools are crucial in gaining situational awareness when degraded visibility conditions are expected or encountered. By utilizing these cues along with the traditional altitude, airspeed, and heading information, the pilot heightens his/her alertness and reaction to unforeseen deviations.

Heads-Up Display (HUD)

The AN/AVS-7 Heads-up Display (HUD) is a NVG mounted monocle system that "displays all information required by the aircrew for flight...to eliminate the need to constantly monitor the instrument panel."[26] Unlike a traditional fixed HUD found in jet aircraft, the AN/AVS-7 is attached

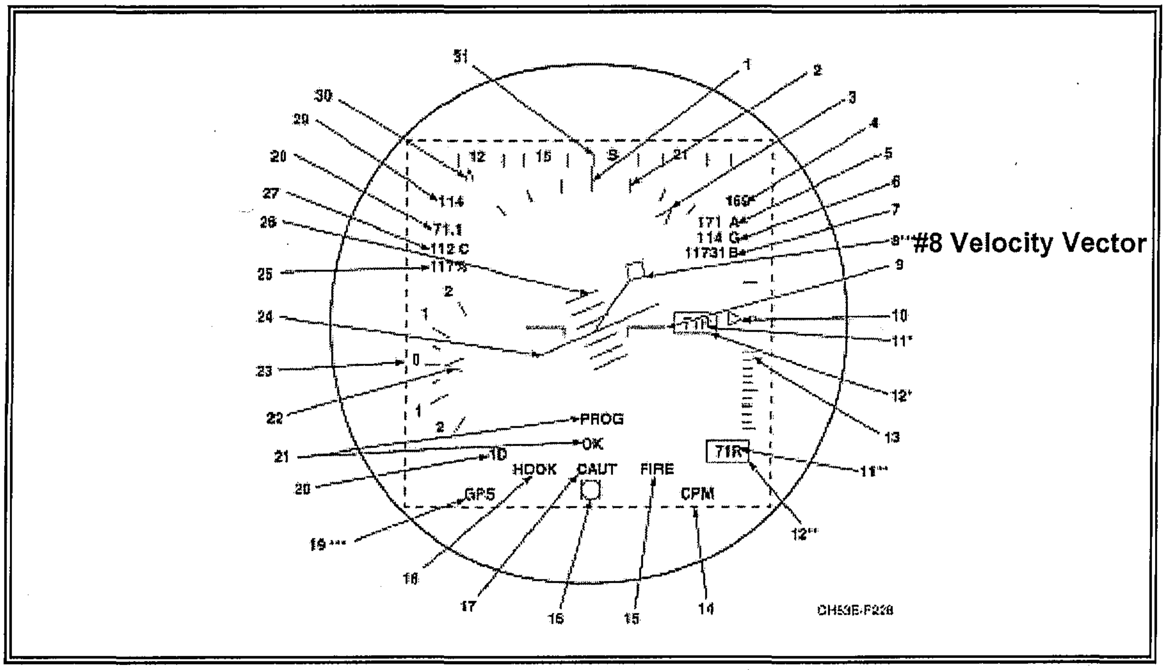


Figure 5. HUD Symbology[27]

to the helmet and moves with the head, allowing pilots to receive continuous aircraft information while they scan outside of the aircraft and inside at the instruments. A velocity vector, similar to the one displayed on the PMD, is accessible to the pilots, however, the acceleration cue is not included

(Figure 5). A total of six flight "pages" and two navigational "pages" are independently programmable, allowing each pilot to customize a set of symbology for each regime of flight he/she is expecting to encounter throughout a mission.

FUTURE SOLUTIONS

Universal Need for Low Visibility Answers

Governmental, commercial, and educational agencies and institutions are aggressively conducting research and development to find a solution for low visibility and brownout conditions. Hi-tech advancements in such areas as optics and lasers have enhanced the development of the next generation of imaging sensor technology. Helicopter pilots in the near future will be able to mitigate visibility issues by visually flying from displays that provide near real-time, digitally generated images of the environment.[28] Even re-engineered anti-brownout rotor blades have been successfully tested and are available by the commercial sector.[29] These collaborative efforts are providing the armed services with a myriad of solutions to an issue that has plagued the helicopter community for years.

In 2006, a USMC Urgent Universal Needs Statement (UUNS) submission from a fleet pilot deployed in support of OIF stated:

> A system is needed to mitigate the risks associated with landing in unimproved zones during reduced visibility conditions where no visual ground reference exists...The system should be integrated with the HNVS and ANVIS/HUD and provide symbology to the pilots in order to facilitate a safe zero visibility landing.[30]

Because of the UUNS, the CH-53E community has begun an aggressive movement to research and evaluate current and future technologies. The USMC is currently in the developmental stages of one of its solutions, the next generation heavy lift helicopter, the CH-53K. Unfortunately, the existing UUNS requirement for the CH-53E necessitates the need for a near term solution, one that cannot be answered today by the CH-53K. Hence, a planned upgrade of the CH-53E fleet with modernized technology is the short-term solution to bridge the gap until the long-term CH-53K becomes available.[31]

Solutions for Today and Tomorrow

Projected to begin initial operational service in 2015, the CH-53K (Figure 6) is expected to answer much of the salient low visibility issues with an integrated and coupled flight director system. Currently in the design phase, the CH-53K is projected to not only provide the pilots with enhanced digitally generated flight symbology and cues on its multi-color Multi-Function Displays (MFDs)

Figure 6. CH-53K[32]

and HUDs, but the aircraft's most significant improvement will be its ability to fly a coupled approach.[33] Unlike the Air Force's MH-53J/M and the Navy's MH-53E, this capability is not available on the CH-53Es. The combination of the motion sensor and auto-pilot features coupled by the CH-53K's robust flight director system will significantly lessen the pilots' workload, especially in the demanding low visibility environment.[34]

To answer the short-term requirements, three modifications are expected to occur in the CH-53E. The first is the possible replacement of the AN/APN-217(V)3 doppler with the newer technology of an Embedded GPS/ Inertial Navigation (EGI) system.[35] The EGI utilizes an internal ring laser gyro, unlike the doppler which uses external radar waves, to measure inertial (motion) changes of the aircraft. The motion information is then fused with position information generated by an embedded GPS receiver.[36] The EGI will provide increased fidelity and accuracy to generate symbology for pinpoint hovering and low-speed regimes. As of this writing, the incorporation of the EGI will occur with the installation of the Directional Infrared Counter Measures (DIRCM) package in late 2008.[37]

Secondly, an evaluation of new EGI-based design ideas for the HUD symbology and the panel mounted displays are currently in progress. Upgrading the symbology and display to represent more environmentally conformal cues will enhance the effectiveness of the system for the pilots. The possible addition of a day HUD will afford pilots the ability for "head-up" use of the EGI information during critical daytime low visibility conditions.[38]

Finally, a Communication, Navigation, Surveillance/Air Traffic Management (CNS/ATM) system upgrade will be the focal point for managing the aircraft, mission, and flight parameters (Figure 7). The upgrade will replace the analog instruments and the HNVS panel mounted displays with five MFDs. EGI generated symbology is expected to be available for "head-down" use on the

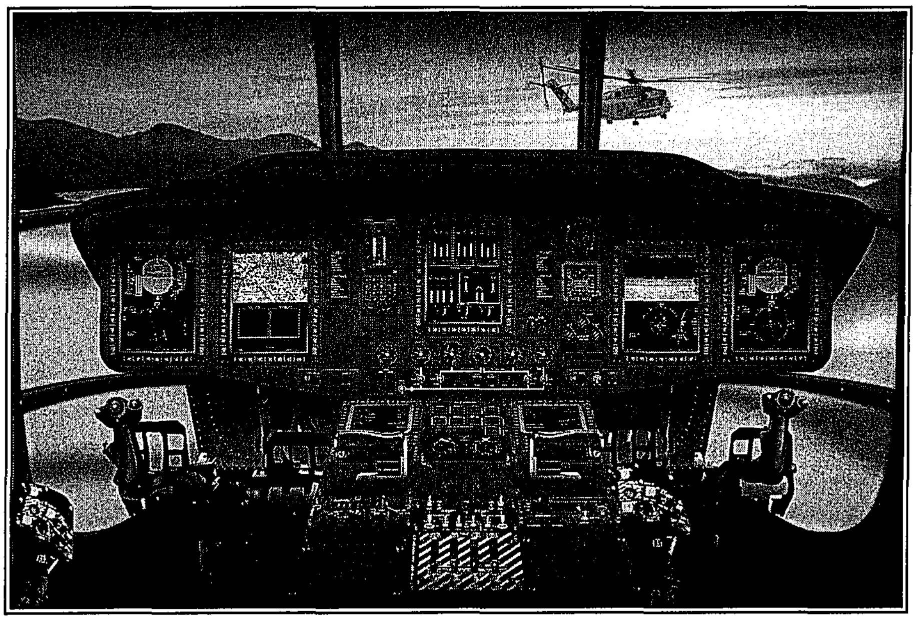


Figure 7. CNS/ATM "Glass Cockpit" Upgrade[39]

MFDs to complement the HUD system. The CNS/ATM "glass cockpit" will also serve in the transition to the CH-53K.

HX-21, the Navy and Marine Corps' Developmental Test and Evaluation (DT&E) squadron, has validated the use of the EGI for motion cuing on other USMC and USN helicopters, but has not yet conducted specific testing and evaluation in the CH-53E. Currently approved for use only with the DIRCM system, the EGI will require new testing before it can be employed with the CH-53E's cuing system. Additionally, as of this writing, the HX-21 test pilots are designing and testing new symbology sets for the future upgrade to the EGI, MFD, and day/night HUD combination.[40] Lastly, the funded CNS/ATM system will begin installation in 2010.[41]

FLYING TODAY

The Standard Pattern

The current operational tempo has produced pilots who have a great deal of time in the desert environment, but are limited in overall flight time experience.[42] Despite the improvements to the aircraft, the "standard landing pattern" or "desert/night vision goggle approach" (Figure 8) prescribed in the ANTTP and reinforced in the November 2007 "Heavy Metal" newsletter remains the same. These tried, true, and tested procedures are not fundamentally flawed, but they are one-dimensional and only incorporate a fraction of the useful HNVS information available to the pilot.

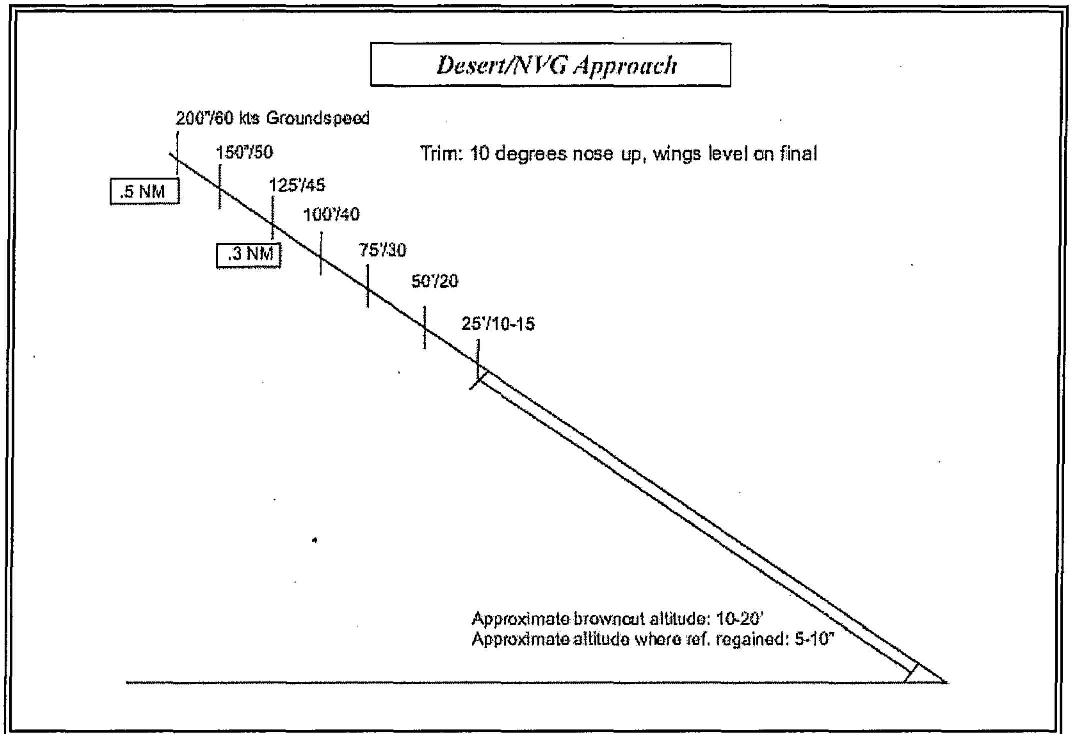


Figure 8. ANTTP Desert/ NVG Approach[43]

Flying a "standard landing pattern" teaches pilots to make the aircraft predictable. Through repetition, pilots train to fly to defined "gates" (checkpoints with specific airspeeds and altitudes) throughout the pattern and to the landing. They learn to recognize deviations and to make adjustments as early as possible to ensure the aircraft is stable and under control as it enters the final phase before landing. Although primarily flown using a visual scan (backed by instrument information), achieving the appropriate airspeeds and altitudes early allows pilots to continue flying through severe cases of degraded or lost visibility without having to make unnecessary control adjustments that can cause a loss of situational awareness or spatial disorientation. More importantly, by avoiding excessive corrections at low altitudes the pilots can minimize their possibilities of a mishap. Finally, whether or not a ground reference can be established, the aircraft, if following the published parameters, can be landed.

The Outside Scan

Throughout the approach, pilots learn to incorporate the primary outside environment cues with the instruments inside the cockpit. The patterns may vary, but the techniques of scanning remain the same across the CH-53E community. A forward "over the console" scan, as seen in Figure 8, provides the pilot a reference to ensure the aircraft is "wings-level" and lined-up with the landing zone. If the forward picture does not represent a level attitude, it may indicate that the aircraft is in an unwanted roll that can manifest in to dangerous lateral drifting.

A visual scan through the lower "chin bubble" allows the pilots to locate a ground reference and to avoid upcoming obstacles in the landing zone (Figure 9). This is a key area to scan while in a hover because it provides the pilot an opportunity to establish a reference point on an object on the ground.

Finally, by using an "over the shoulder" scan (looking through the side window) pilots are able to acquire the relative forward speed and decent rate of the aircraft (Figure 9). While on the approach, in the hover, or attempting to land, aggressively scanning "over the shoulder" can capture any lateral or longitudinal drift that might compromise a safe landing. Additionally, due to the aircraft's design, the space just below the pilot's window and forward of the sponsons (Figure 9) often becomes the last area a dust cloud will compromise. By finding and retaining a reference in this area, pilots can often land the aircraft safely. Crosschecks of instrument and gages coupled with the copilot's and aircrew's verbal "calls" completes the teamwork needed to maneuver and land the aircraft safely.

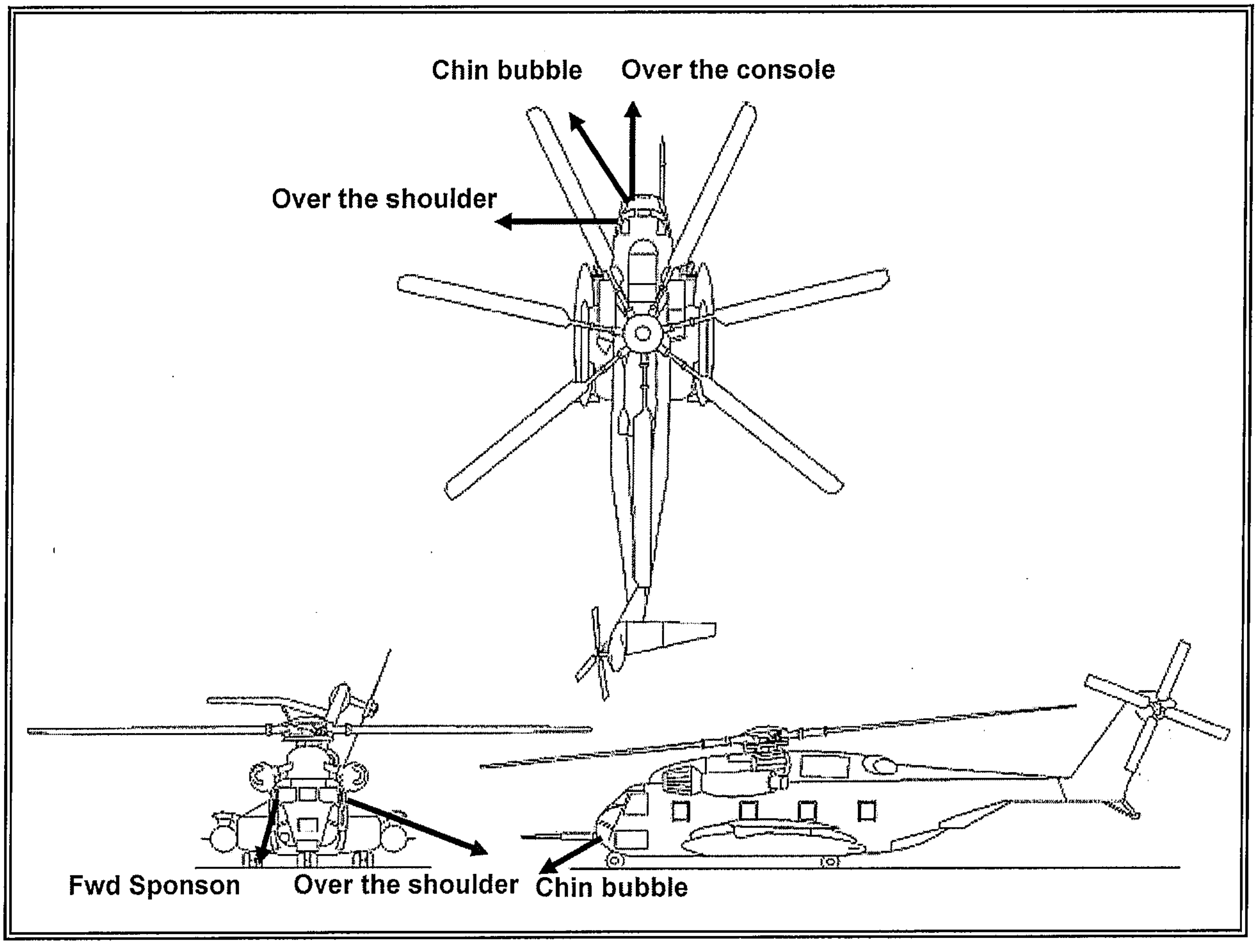
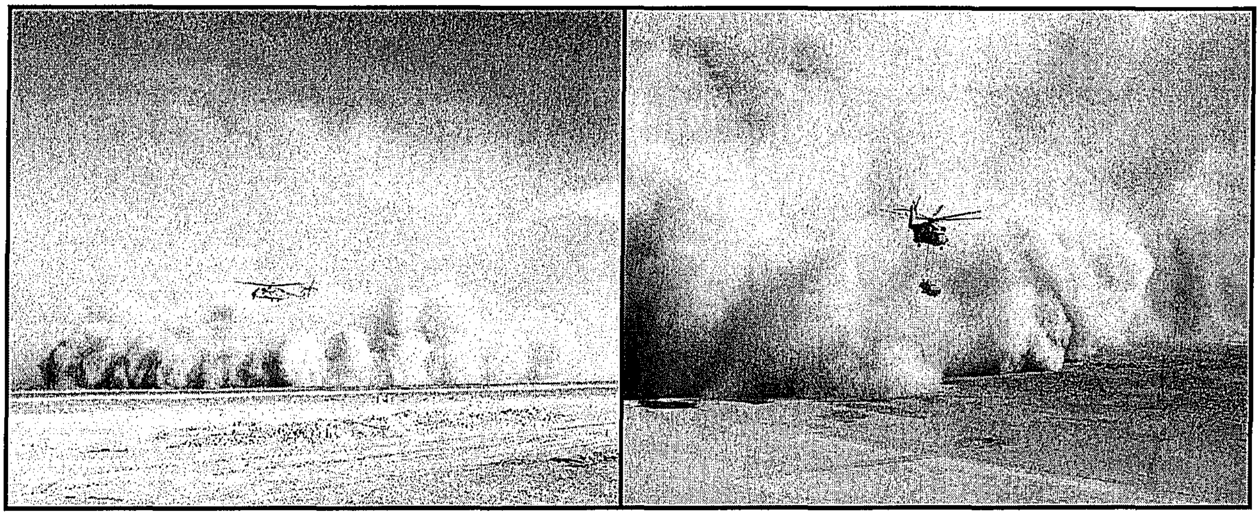


Figure 9. CH-53E Outside Scan[44]

<u>There is a Difference in Height</u>

Dependent on such variables as aircraft weight, soil composition, or approach profile, degraded visual conditions can begin upward of 100 feet and continue throughout the entire approach until the aircraft has landed (see Figure 10). Unfortunately, the ANTTP does not address this issue, rather the procedures for "desert/night vision goggle" conservatively states that the approximate brownout altitude is 10'-20' with the approximate altitude to regain references at 5-10 feet. This may be what an average landing might generate, but pilots should not be trained to such assumptions. The USAF MH-53 community describes this danger more realistically by stating that the "entry into the obscuration may occur as high as 100 feet, depending on the surface composition."[45]



Note: CH-53E Fuselage Length- **73' 3.92"**, Rotor Diameter- **79'**

Figure 10. CH-53E Low Altitude Desert Flight[46,]

The differing characterization suggests that the CH-53E community needs to address procedures that will mitigate the additional 80 feet of possible degraded conditions pilots could encounter. Depending on the descent rate, that could be an additional 15-24 seconds of possible zero visibility conditions that pilots will have to contend with in their attempts to land. Day or night, this is difficult to mitigate without additional information to verify the aircraft's profile. It is during this period that spatial disorientation, as discussed before, can manifest into an unrecognized lateral drift that can end in an accident.

Even if pilots fly all the correct parameters prescribed by the ANTTP and NATOPS manuals, they are still susceptible to encountering several seconds where visibility is lost around the entire aircraft. During that time while taking off or landing, the pilots are only able to react to what the aircraft was doing prior to entering the zero visibility condition; thereafter they will be flying blind in the lateral axis. If within that time the attitude of the aircraft changes or the pilot gets spatial disorientation, an unrecognized and uncorrectable lateral drift can occur. Whether the obstacle is a tree or another aircraft, as was the case at Desert One, the pilot's loss of situational awareness can lead to disaster.

Fortunately, the CH-53E has the capability to provide its pilots with the additional information they need to lower the risks of flying in these conditions. The assimilation of the doppler cuing capability into the "standard approach" and takeoff procedures is the first step in addressing the short-term need for risk mitigation in degraded conditions. Pilots already, by training, back-up their flight parameters via the analog instruments and the digital information displayed on the PMD or HUD. Adding the velocity vector to the scan on an approach or takeoff provides discrete information found nowhere else. By utilizing the proven parameters outlined in the ANTTP backed by doppler generated velocity vector information, pilots who encounter low visibility conditions will confidently be able to determine if the aircraft's profile is stabilized for landing or if they need to "waveoff" for another try or another day.

TACTICS, TECHNIQUES, AND PROCEDURES

The Foundation for Training and Readiness

The tactics, techniques, and procedures (TTPs) taught today are in no way inadequate for pilot development; rather, they lack the additional training needed to access valuable information that could lighten the workload in the terminal phase of flight. As the aircraft has matured with technological advancement, certain aspects of the Training and Readiness (T&R) syllabus have not followed suit. Additionally, CH-53E foundational manuals, such as the Combat Aircraft Fundamentals (ANTTP) and the Naval Aviation Training and Operating Procedures Standardization flight manual (NATOPS), have not matured in the doppler's use to be reliable references. Because of training and reference inefficiencies, it is important the CH-53E community give some attention to these issues.

The CH-53E T&R syllabus provides the framework and guidelines needed to train fleet pilots for combat. Using a building block approach, it divides groups of specific training events into three core skill levels (introduction, basic, advance). A fourth (plus) level, compiles specialized training, such as parachute operations, needed by pilots, but not necessarily inline with the building block program. The T&R syllabus delineates specific goals, training requirements, and performance standards to be accomplished upon the completion of the event (Figure 11). Further details outline the required discussion items for the preflight briefing and the maneuvers to introduce, practice, and review during the flight. The progression within the three core skill levels develops the pilot from basic aircraft maneuvering to tactical multi-aircraft nighttime employment. When pilots complete the third core skill block, they are ready to become Helicopter Aircraft Commanders.

The methodology and structure of today's T&R syllabus are effective and sound; unfortunately, its content has fallen behind the times. If the T&R is a "collaborative effort of CH-

NAVMC DIR 3500.59
20 Jan 06

Range Requirements. Live fire AG range (.50 cal). CAL/MAL site. Approved TERF maneuver area/route.

TAC-291 2.0 R,SC 2 CH-53 NS

Goal. Conduct assault support tactical missions in a low threat environment at night.

Requirement

Instructor:
NSI required for initial qualification and re-qualification.

Discuss:
Same as TAC-290.
NS planning, briefing, and execution considerations

Introduce:
NS planning, briefing, and execution considerations.

Review:
TAC-290.
HNVS and HUD operations.

Performance Standards. Same as TAC-290.

Prerequisite. CAL-223, TERF-233, and TAC-290 (AG-380 if .50 cal to be employed).

Ordnance. 2 .50 cal (TG and .50 Cal rounds optional reference Chapter 2 of CH-53 T&R).

Range Requirements. Live fire AG range (.50 cal). CAL/MAL site. Approved TERF maneuver area/route.

Figure 11. Example T&R Syllabus Event[47]

53 Subject Matter Experts who designed training standards *to maximize the full combat capabilities of the CH-53* and its crew,"[48] then why is the syllabus missing training requirements for the HNVS's doppler cuing capability? As it stands today, the training program does not provide instructors with detailed guidelines to teach pilots the intricacies of the HNVS system.

The T&R syllabus (see Appendix B) includes 93 training events across the three core skill levels. Of these, ten have a requirement for the HNVS; with only five requiring an introduction or review of the system in flight (see Table 1). No other details are provided to the student or instructor to discuss, introduce, practice or review the specific capabilities of the HNVS. Without detailed guidelines, the FLIR becomes the only component used by pilots, completely ignoring the ability of the doppler to enhance their flight awareness. Additionally, without dedicated instruction of the full system in

Trng Event		Specific Descriptions for HNVS T&R Syllabus Requirements	
FAM	120	*Introduce*:	HNVS Operations.
NAV	140	Goal: *Introduce*:	HNVS. Use of Global Positioning System (GPS) and HNVS Operations.
FORM	211	Discuss: *Introduce*:	HNVS Considerations. NS navigation to include GPS and HNVS checkpoint
CAL	220	Discuss:	HNVS capabilities and limitations.
CAL	222	Discuss:	HNVS capabilities and limitations.
CAL	224	Goal: Discuss:	Introduce ANVIS-7 (HUD) and develop proficiency with CH-53 NS to include HNVS and NS. HNVS.
TERF	232	Discuss: *Review*:	HNVS capabilities and limitations. HNVS Operations.
TAC	291	*Review*:	HNVS and HUD Operations.
CAL	322	Goal:	Introduce ANVIS-7 (HUD) and develop proficiency with CH-53 NS to include HNVS and NS under LLL conditions.
AR	362	Discuss:	NS/HNVS considerations.

Table 1. Ten HNVS T&R Requirements[49]

flight or simulator training events, pilots will remain naïve to the full capabilities it can provide.

Unfortunately, this is not just an inconsistency in the current 20 January 2006 version of the T&R. The lack of detailed training guidelines for the HNVS has been prevalent since the 2000 version of the T&R. Generations of pilots have had no formal instruction in the HNVS's (including doppler) capabilities. Since the HNVS' incorporation in 1995, the model managers of the T&R program, formerly HMT-302 and currently MAWTS-1, have discounted its use in training and mission operations.

ANTTP...The Toolbox for Tactics, Techniques and Procedures

Additional deficiencies found in support manuals compound the problem associated with the

T&R syllabus. Developed from "lessons learned from previous conflicts, operational evaluations, training exercises, tactics development programs, and threat analysis,...[the ANTTP]...provides an organized and functional tool for successful mission planning and execution."[50] Unfortunately, even the most current version, dated November 2006, does not address the use of doppler generated information, even as a secondary reference. Although it outlines the TTPs practiced today for mitigating degraded visibility conditions, such as using instrument takeoff procedures, no-hover landings, and even infrared lighting for landing, it fails to recommend anything else.

As an example, in the section labeled "Desert/NVG Approach Final," the manual suggests that the "approach, will ensure the aircraft will be on a glide-slope (descending or decelerating) to allow for visual acquisition of the LZ while setting the crew up for the *best possible chance* of landing in brownout conditions."[51] So the question remains: Does the "Desert/NVG Approach" alone offer the "best possible chance" for landing safely, or can the addition of Doppler generated cues make it better? Until an educational leap occurs with the community, the doppler system will remain difficult to understand.

NATOPS...The Aircraft Bible

The CH-53E NATOPS manual encompasses a broad-spectrum of information that ranges from aircraft systems to pilot procedures. Again, similar to the ANTTP, the NATOPS fails to suggest possible employment options for the doppler system in any regime of flight. In fact, a section on desert operations, located in the chapter labeled "Extreme Weather Operations," only outlines general courses of action for flight in these conditions. The manual recognizes the danger of "heavy sand/dust may result in disorienting IFR conditions," but does nothing more than to say:

> Execute a normal takeoff and climb as rapidly as possible... [Enroute] avoid flying through sand/dust storms when possible...The best procedure for landing, to reduce blowing sand/dust, is a rolling landing, if conditions permit. If conditions do not permit a rolling landing, fly a

minimum power approach with a no hover landing.[52]

These suggestions for an "extreme" desert environment do not capture the reality of what pilots are encountering today. Surprisingly only two sections in the NATOPS, totaling roughly a page and half, are devoted to the doppler radar system, one for its description and another for calibration instructions.

UNCOVERING THE MYTHS

Community of Skeptics

The CH-53E community has been uncomfortable in accepting the full capabilities of the HNVS. Specific criticism aimed at the lack of fidelity in the doppler's information, especially in the hover regime, has become the rationale against its use. Armed with these unsubstantiated opinions, generations of aviators have opted to avoid employing the HNVS system. In an effort to mitigate the risks of low visibility or brownout conditions, pilots must look past the deficiencies of the doppler to uncover its relevant capabilities.

A survey of five squadrons was conducted to determine the depth of the claims made by the community. Thirty-seven respondents, encompassing a range of flight-time experience from 650-3000 hours in model, represented a cross-section of the CH-53E community— a west and east coast fleet squadron, Marine Heavy Helicopter Training Squadron (HMT)-302, Marine Aviation Weapons and Tactics Squadron One (MAWTS-1), and HX-21. The survey yielded two common and steadfast views that represent the skepticism of the doppler system's reliability in everyday operations.

The first of these concerns was that, "The doppler does not have the fidelity for precision hovering in a brownout condition." Although some credence can be given to this concern, the issue has caused pilots to shy away from other possible uses of the doppler as a reference tool for gaining situational awareness. Unfortunately, the common perception is that the Doppler only provides information for hover symbology. In an evaluation conducted by HX-21 test pilots for this research, the pilots agreed with the concerns regarding the system's ability for precise hovering, but they also acknowledged that it was a reliable source of information in providing drift cues while the aircraft is on an approach and takeoff.[53] Navy MH-53E pilots echoed the findings for the hover; moreover, they commented that their use of the Doppler (AN/APN-217) for drift control incorporated the vector cues of their Attitude Director and Ground Speed Drift Angle indicators.[54]

As described in Chapter 3, the HNVS provides the pilot with Doppler generated symbology in three separate modes (HVR, TRNS, PSN), which are scaled to the specific regime of flight. There should be a focus placed on the capability of the velocity vectors in all three modes to aid in drift recognition, rather than to dwell on its inaccuracies in the hover.

The group's second concern was that, "Calibrating the HNVS before a flight is impractical and consumes too much time." Published hover and doppler calibration procedures in the NATOPS are a requirement for the completion of a "B" profile functional checkflight (FCF).[55] Unfortunately, these requirements are rarely met. The survey respondents were asked how often they fully calibrated the HNVS as either the Functional Check Pilot (FCP) or the FCP co-pilot. An overwhelming 85 percent of the respondents replied that they frequently did not complete the

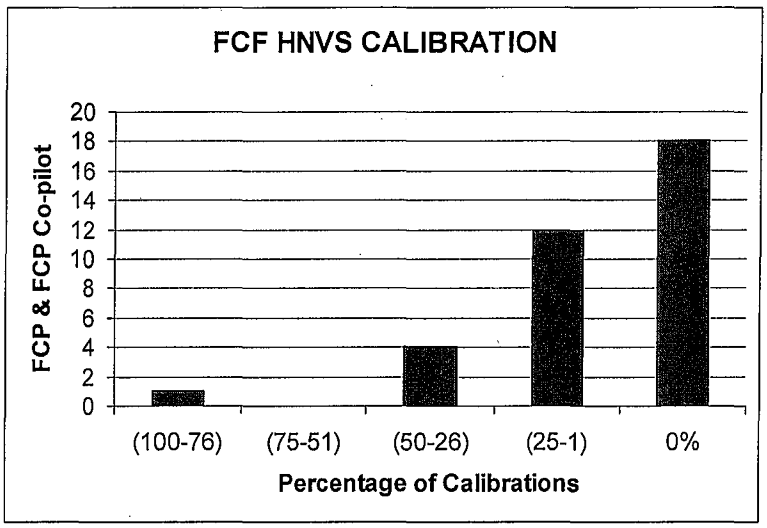


Chart 3. FCF HNVS Calibration[56]

required FCF procedures (see Chart 1). By omitting the doppler calibration, which requires a five-minute hover, FCPs provide another reason for pilots to discount the capability.

Prior to conducting training or real world operations, calibration requirements should not encumber pilots "if they want to use the system;" instead, they should receive the aircraft fully prepared to conduct their mission. Although the published FCF procedures are the "minimum checklist items required" to complete the specified profile, authorization from Quality Assurance Representative (QARs) to modify the checklist based on post-maintenance requirements occurs.[57] Unfortunately, excessive amount of FCFs have been accepted by both FCPs and QARs with these requirements incomplete, consequently rendering the system unusable until another pilot can "find time" to calibrate it.

The research suggests that pilots have opted to forgo using the doppler capabilities, not because of its ill-perceived flaws, but instead from a lack of education and training. Survey results revealed that even without formal training, pilots had negative opinions about the system. Aviators were asked to respond to statements regarding the use of the doppler information in the PMD (Chart 4) and HUD (Chart 5) during landings and approaches. Comparing their "suitability" responses with

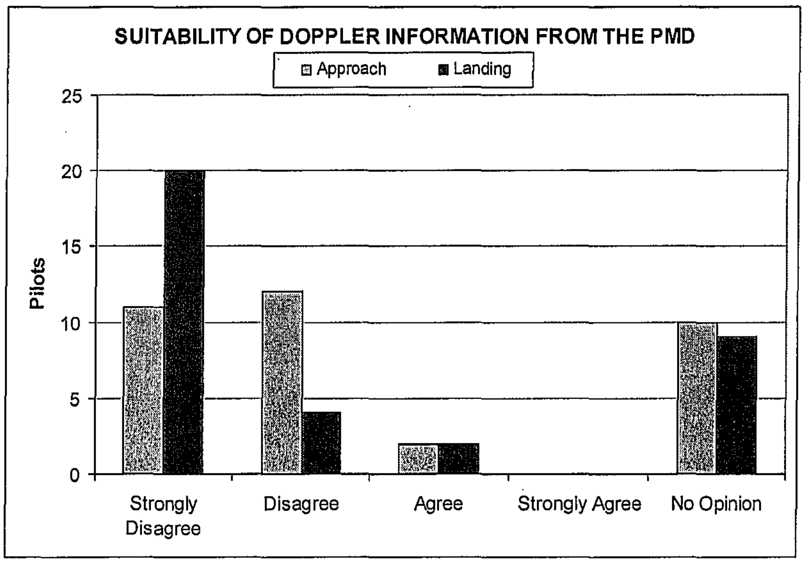


Chart 4. Suitability of Doppler Information from the PMD[58]

Chart (6), which asked if the pilots had any ground, flight, or simulator training, the lack of correlation is dramatic. A majority of the respondents disagreed with the system's suitability, yet had no formal training or experience to support their claims. Without guidance, fleet aviators become "casual" users of the system, creating opinions, good and bad, that permeates the entire community through "word of mouth". Hence, to develop experience in the doppler system, a change in the current cycle of training and operations should be made. The two statements mentioned earlier reflect myopic views that will require a formalized T&R syllabus to ameliorate.

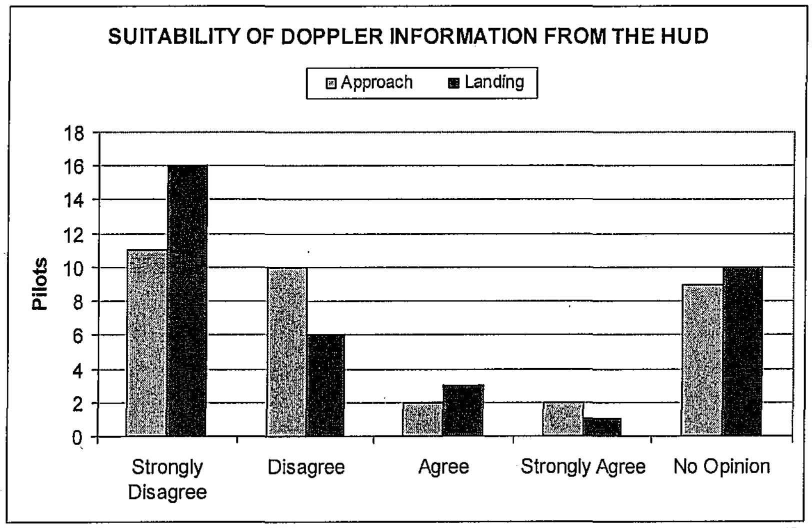


Chart 5. Suitability of Doppler Information from the HUD[59]

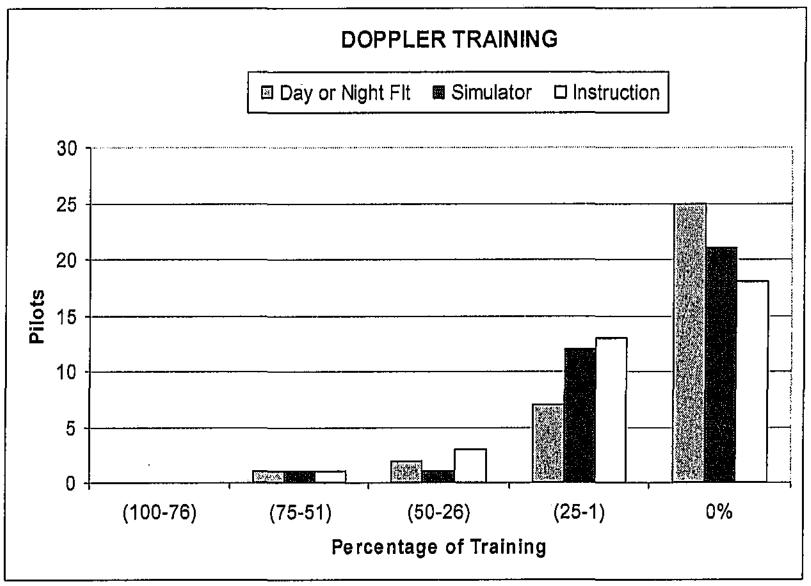


Chart 6. Doppler Training[60]

Learning from the Aircraft

The relevance of the doppler for drift mitigation should not be solely for casual users; instead, it should become an active source of information for all pilots. If left unaddressed, generations of pilots will remain unaware of its capabilities, thus committing the HNVS's function exclusively to its FLIR ability, which is prevalent today.

An example of CH-53E technology lost to generations of pilots is the CG/Hook load indicator. Included in the original CH-53E design, the indicator provides a computer updated display of helicopter center of gravity, weight, and moment, and displays the loads on both the forward and aft cargo hooks. The lack of education in the indicator's use, as Chart 7 reveals, has resulted in pilots who believe it is a "worthless" piece of gear. Surprisingly the indicator will remain in the aircraft with the CNS/ATM "glass cockpit" upgrade where it will continue to remain unused.

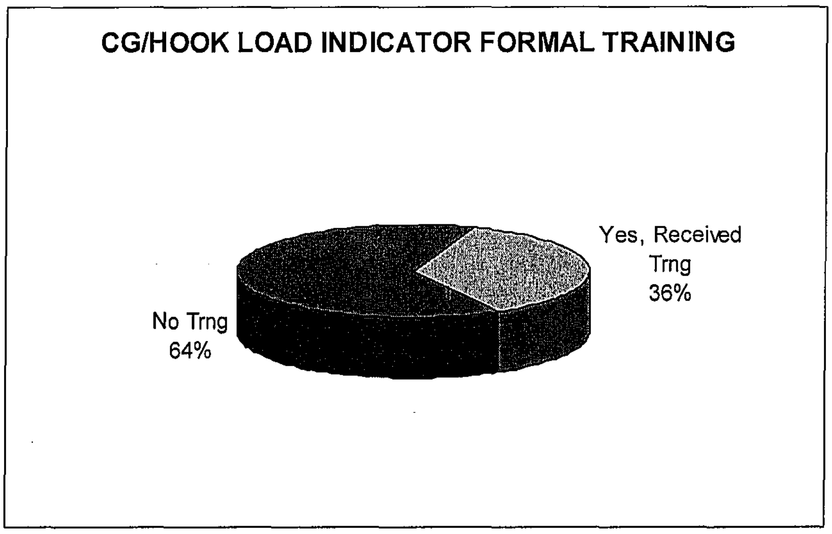


Chart 7. CG/ Hook Load Indicator Training[61]

A second example of technology that was not properly received through formalized training is the AN/ANVIS HUD. Introduced to the CH-53E community in January 2000, the HUD's incorporation did not occur in the T&R syllabus until 2003. Older generations of pilots had

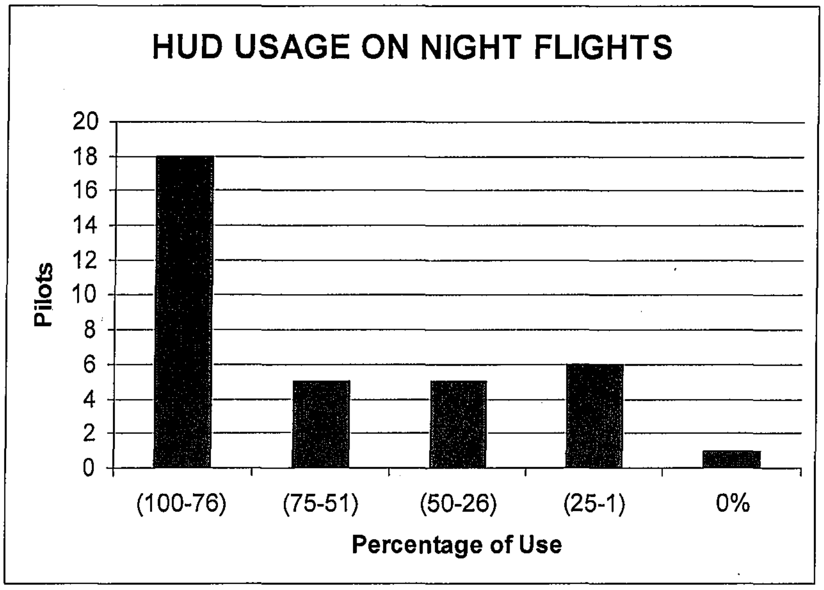


Chart 8. AN/AVS-7 HUD Usage on Night Flights[62]

developed techniques and habits that did not include the HUD; therefore, they would not use it on training or mission operations. The lack of experience and instruction from senior pilots has left newer generations to learn and to use the HUD on their own accord, creating another crop of "casual" users. Fortunately, since the incorporation of HUD training, over 50 percent of the respondents use the HUD on three quarters or more of their flights at night. Still, as Chart 8 reveals, "casual" users who are still prevalent in the community.

The increase of situational awareness remains the foundation of the research concerning the doppler. Nevertheless, a secondary issue is the possible shortfall in experience as the airframe transitions to the EGI generated cuing system, CNS/ATM cockpit, and ultimately the CH-53K. If experience is not spawned today, especially through a change in the T&R syllabus, the technology that is presumed to answer the visibility concerns will in itself become a hazard. As described earlier, the near-term solution for degraded visibility mitigation will be an updated and robust version of today's doppler system. If the CH-53E community ignores this opportunity to begin instruction with the current system, they could relive the same pitfalls outlined earlier. Avoiding "casual" users and "generational" pilots will ensure the employment of the future capabilities for the reasons they were requested.

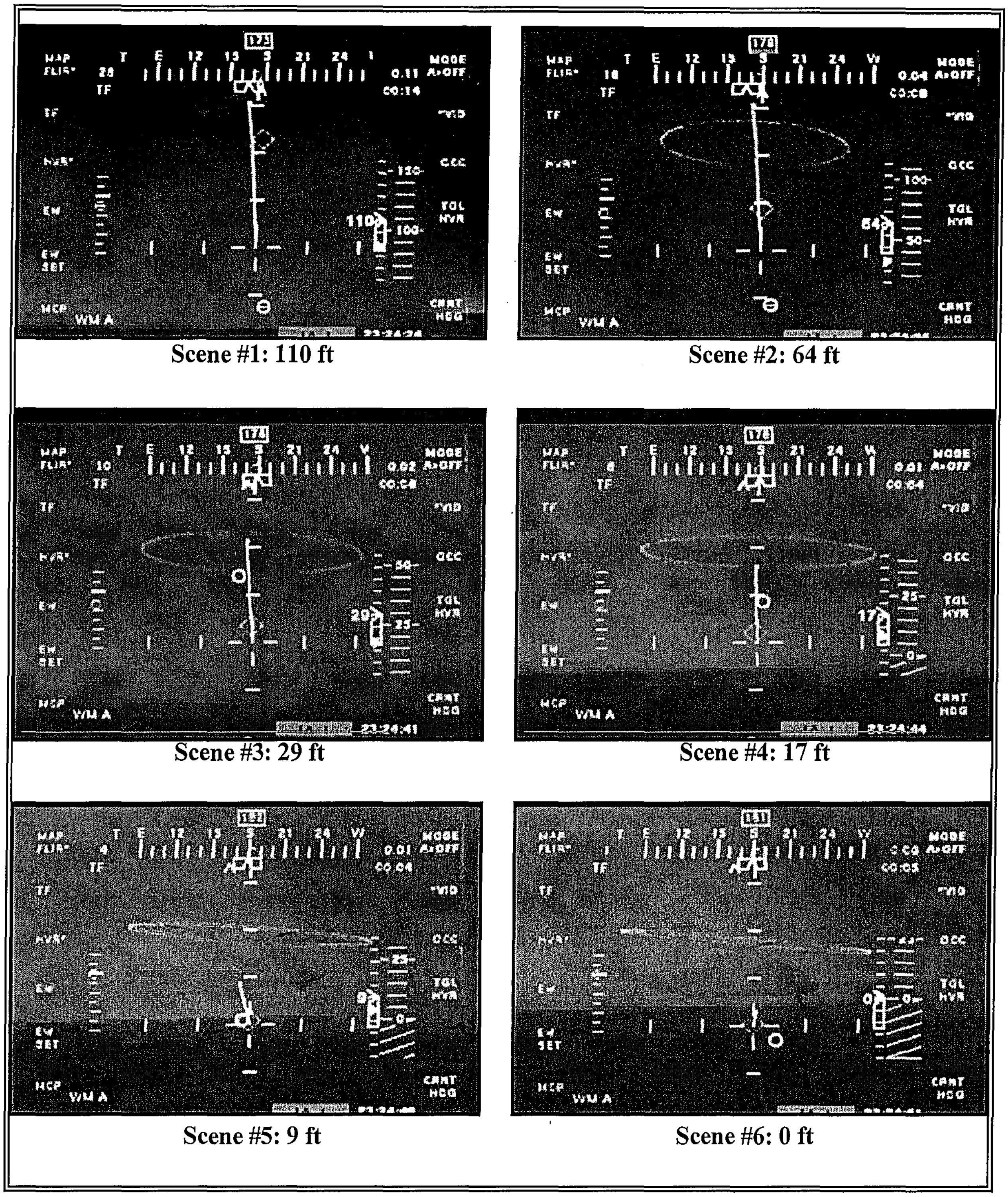
RECOMMENDATION

The proof of the Doppler's capabilities will rely solely on its employment by fleet pilots. Therefore, it is the CH-53E community's responsibility to encourage aviators to aggressively explore and integrate possible applications of the technology. Focusing on the hover regime may not be the answer, but it is a leaping point to continue research. The following recommendations establish a framework for the community to build on.

MAWTS-1. As the T&R and TTP managers, the CH-53E division must begin the evaluation of possible venues for using the doppler cuing system in degraded visibility regimes. MAWTS-1 should enlist Weapons and Tactics Instructors fleet wide, to assist in practical aircraft evaluations to develop possible employment methods and techniques. They should integrate detailed guidelines for HNVS/ Doppler training in the T&R syllabus and ANTTP. Finally, MAWTS-1 should coordinate with HMT-302 to incorporate the changes into the NATOPS.

T&R. The T&R syllabus lacks depth of instruction on the HNVS. Since it encompasses both the FLIR and doppler, the event card must have more definition and guidance for each particular system. Dedicated doppler flight events are required to understand the capability and should be included as a "review" item with other training events. Simulator and flight training should reflect the standard progression from day, high-light night, to low-light night training. Lastly, training should focus on the pilot's ability to recognize and react to the detected drift by the velocity vector. A suggested T&R syllabus card, developed by HMH-769, is located in Appendix C.

FCF. Maintenance departments and FCPs must ensure that they do not ignore the requirements for the HNVS calibration on FCFs. Consistent calibration will pay dividends for training and mission operations.



Scene #1: 110 ft

Scene #2: 64 ft

Scene #3: 29 ft

Scene #4: 17 ft

Scene #5: 9 ft

Scene #6: 0 ft

Figure 12. MH-53J Low Visibility Approach with Velocity Vector[63]

Single Aircraft Employment (Figure 12). The doppler cuing system provides a uniquely exploitable capability. The technique utilized by MH-53J/M pilots should be emulated and incorporated into the CH-53E community's TTPs (Figure 12). Pilots should incorporate the velocity vector to mitigate drift errors on approaches, no-hover landings, and takeoffs. In the approach, the pilots should utilize the TRNS page (<= 60 KIG); while on short final, they should switch to the HVR or PSN page (<= 5 KIG). While taking off, the pilots should reference the HVR or PSN page's velocity vector to ensure a straight departure from the degraded conditions.

Multiple Aircraft Employment (Figure 13). Current TTPs recommend multi-aircraft formations to stagger their landings to avoid flying into the previous aircraft's debris field. Unfortunately, there may be a need to expedite a landing; in such cases, using the velocity vector can

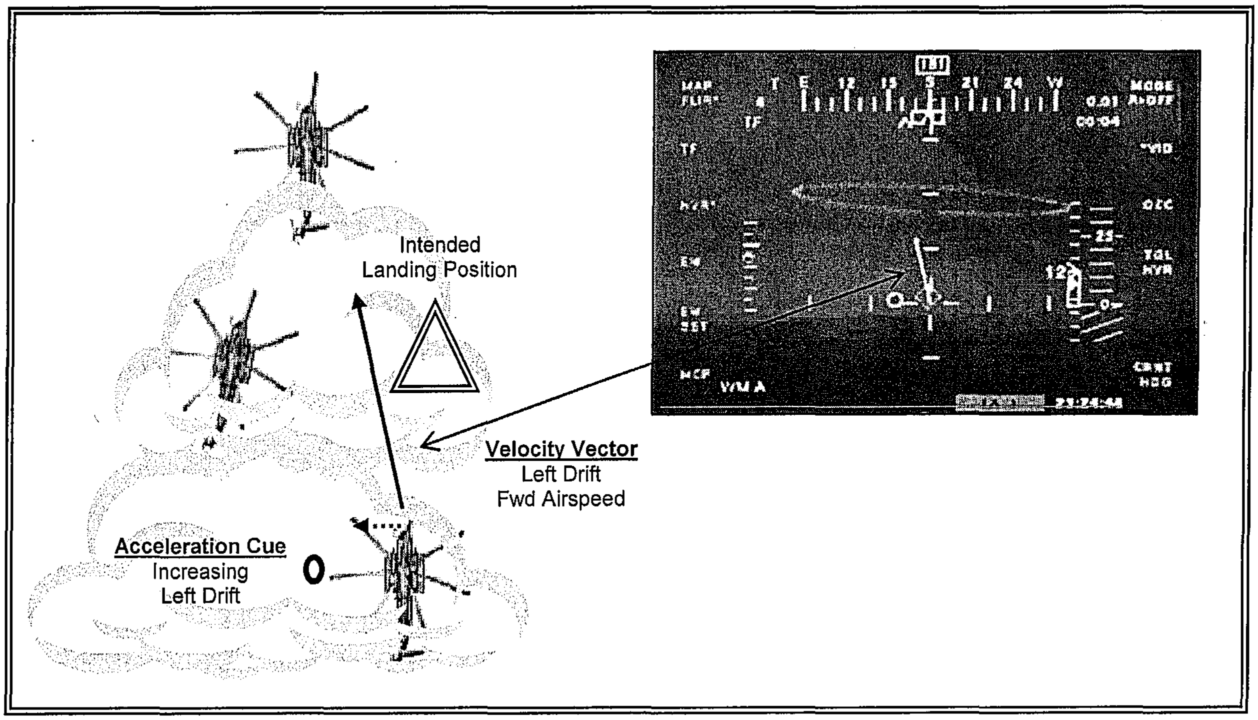


Figure 13. Example Multi-Aircraft Landing[64]

help mitigate the possibility of a mishap caused by an unrecognized drift while the aircraft are in close proximity of each other. The vector can represent the specific landing "lane" where the aircraft needs to remain. Any deviations of the vector while in the debris cloud can facilitate the pilot's decision to continue either to the intended landing position or to "waveoff" for another attempt. Subsequently, the same holds true in the departure phase. As the pilot takes off into the airborne debris he/she can use the cuing system to remaining in their assigned "lanes" until visual reference can be gained of the other aircraft in the formation. Once established, the flight can continue maneuvering.

The five recommendations are a starting point to begin understanding the capabilities of an undervalued and disregard system that is applicable today just as it was several years ago. Therefore, as professional military pilots, it is imperative that the CH-53E community responsibly prepares the pilots who sit in the cockpit today with all available tools and information the aircraft can provide.

CONCLUSION

The Desert One disaster is a tragic example of the continuous struggle between the pilot, aircraft, and the environment. At any given moment, pilots must be prepared to confront unexpected events such as aircraft emergencies or extreme environmental conditions. How pilots respond and what tools they employ to mitigate the situation are vital to the aviator's survival. Aircraft technology has come a long way, offering features that can enhance awareness and lessen the workload, but they are useless if pilots do not appreciate their potential. If Major Schaefer, in 1981, had a system for drift recognition, could he have avoided the collision with the C-130 at Desert One? Today, those same challenges remain a reality for pilots flying in the deserts and mountains throughout the globe. Though the environmental conditions that Major Schaefer encountered have remained the same, one important distinction that has made a difference in the pilot's ability to mitigate those challenging regimes has been the aircraft.

Through upgrades and modifications, today's CH-53E has become a more effective and efficient combat platform. Sensory improvements from the addition of the HNVS and HUD have increased the array of accessible information, thus providing the pilots with tools to mitigate taxing situations. Sadly, the full capabilities of the HNVS and HUD remain ambiguous, resulting in its biased employment by the community. Without a full understanding of the system, pilots are susceptible to repeating the same mistakes that warranted the development of the technology in the first place.

The CH-53E community must look past their prejudices of the HNVS system and begin a creative evaluation for possible solutions to integrate its capabilities into the current TTPs. Pilots should have the opportunity to learn and train with the HNVS/doppler system, rather than a portion of it. The validation of its capabilities relies solely on its employment by the community, rather than by skeptics who have labeled it before using it. Our responsibility as professional pilots is to fully understand and utilize all the capabilities of the aircraft. Flying thirty Marines to an unknown desert landing zone on a low-light night is reason enough to appreciate the extra information that the aircraft could provide.

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[44] Figure created by the author utilizing images from A1-H53BE-NFM-000.

[45] Air Force Tactics, Techniques, and Procedures (AFTTP) 3-3.MH-53, *Combat Aircraft Fundamentals MH-53*, 15 June 2007, (Nellis AFB: USAFWC/561 JTS), 7-10.

[46] Photo (.jpg) from Wayne Cowan "Brownout" powerpoint presentation.

[47] NAVMC DIR 3500.89 (T&R), 1-73.

[48] NAVMC DIR 3500.89 (T&R), 1-3.

[49] NAVMC DIR 3500.89 (T&R), 1-35, 43, 55, 57, 58, 59, 62, 73, 75, 82.

[50] ANTTP 3-22.3-CH-53,

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[52] A1-H53BE-NFM-000, 14-7.

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[54] Scott Hatch, Lieutenant USN (HM-15), Phone interview by author at USMC Command & Staff College, 22 March 2008.

[55] A1-H53BE-NFM-000, 10-41,10-42.

[56] The results are from a survey conducted by the author (Appendix A).

[57] OPNAVINST 4790, *Naval Aviation Maintenance Program*, Naval Air Systems Command.

[58] Author's survey results.

[59] Author's survey results.

[60] Author's survey results.

[61] Author's survey results.

[62] Author's survey results.

[63] AFTTP 3-3.MH-53, 7-17.

[64] Figure created by the author utilizing images from AFTTP 3-3.MH-53.

APPENDIX A

-Training percentages reflect the ***approximate*** hours applied to doppler training using the FLIR or HUD (a non-T&R event) WRT your cumulative T&R syllabus training hours.
-FCF percentages reflect the ***approximate*** number of times HNVS calibration was completed WRT your (FCP or copilot) cumulative number of completed A & B cards.
-Doppler information displayed as: FLIR- velocity vector, acceleration curser, vertical velocity caret or position reference box
HUD- velocity vector

(1) How often do you use a HUD on night flights?					
	5 (76-100%)	4 (51-75%)	3 (26-50%)	2 (1-25%)	1 (0%)
(2) On an approach and landing to an LZ, how much symbology do you display in the HUD? (In any mode)					
	5 (15-20+)	4 (10-14)	3 (5-9)	2 (1-4)	1 (0)
(3) How often have you conducted **day or night** flight training (approaches, hovering, landing) utilizing the doppler information displayed on the HUD or FLIR? *CAN be: a **dedicated training** event OR **using extra time** on a completed hop OR **incorporating** it into a syllabus event.*					
	5 (76-100%)	4 (51-75%)	3 (26-50%)	2 (1-25%)	1 (0%)
(4) How often have you conducted **simulator** training (approaches, hovering, landing) utilizing the doppler information displayed on the HUD or FLIR? *CAN be: a **dedicated training** event OR **using extra time** on a completed hop OR **incorporating** it into a syllabus event..*					
	5 (76-100%)	4 (51-75%)	3 (26-50%)	2 (1-25%)	1 (0%)
(5) How often have you conducted dedicated **ground training** (pilot training, flight brief etc.) on the doppler's capability and use?					
	5 (76-100%)	4 (51-75%)	3 (26-50%)	2 (1-25%)	1 (0%)
(6) How often have you calibrated the HNVS system IAW Chapter 10's A & B-Card FCF procedures?					
	5 (76-100%)	4 (51-75%)	3 (26-50%)	2 (1-25%)	1 (0%)

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion
(7) The doppler information displayed on the ***FLIR*** is not suitable to conduct low visibility or brownout ***approaches***.	5	4	3	2	0
(8) The doppler information displayed on the ***HUD*** is not suitable to conduct low visibility or brownout ***approaches***.	5	4	3	2	0
(9) The CH-53E T&R syllabus sufficiently provides guidelines to train pilots in utilizing the aircraft's systems in a low visibility or brownout approach or landing situation.	5	4	3	2	0
(10) The doppler information displayed on the ***FLIR*** is not suitable to conduct low visibility or brownout ***landings***.	5	4	3	2	0
(11) The doppler information displayed on the ***HUD*** is not suitable to conduct low visibility or brownout ***landings***.	5	4	3	2	0
(12) The low reliability of the doppler/FLIR/HUD system does not warrant a complete calibration during an FCF.	5	4	3	2	0

(13) Why **do/don't** you use the doppler/FLIR/HUD system?
(14) What HUD symbology do you personally display while in the approach profile to a landing?
(15) Do you know how to use the CG/Hook load indicator? **(YES/NO)**
(16) Have you received formalized training for the CG/Hook load indicator? **(YES/NO)**

Approximate total flight hours:________________ Approximate CH-53E flight hours:______________

Please provide any additional feedback, remarks, or opinions regarding the current capabilities of the aircraft or pilot WRT low visibility or brownout operations. Thank you for conducting this survey.

APPDENDIX B

For use by MCCDC Assessment Branch

CDTS Short Title	
CDTS#	Date CDTS # assigned

UNIVERSAL NEED STATEMENT (UNS)
Part 1a of 5 - Originator's Request

PURPOSE

The completed Universal Need Statement is the most important information component in the Expeditionary Force Development System (EFDS). As the primary means of entry into the EFDS, the UNS acts as a "work request" for current and future capabilities within the EFDS. The UNS identifies operational enhancement opportunities and deficiencies in capabilities. Opportunities include new capabilities, improvements to existing capabilities, and elimination of redundant or unneeded capabilities. "Universal" highlights its common use by any Marine Corps organization to capture both current needs and future needs developed through analysis, assessment, and experimentation with future warfighting concepts.

Originator

Name (Last, First, Initial)	Rank/Grade	Phone	FAX
Mullins, Michael, B.	MAJ	DSN 267-4881; (858) 577-4881	DSN 267-4883; (858) 577-4883

Available for phone or personal follow-up?		Interested in participation on Solution Course of Action IPT?		Request UNS status updates by e-mail?		E-mail	RUC
	Yes		Yes		Yes	mullinsmb@3maw.usmc.mil	01465

Type of Need (select one that best describes the need)

ADD a new capability that does not exist	X	IMPROVE or FIX an existing capability		REMOVE an existing capability	

Description of Need
Describe the nature of the need and the cause (if known). Explain how the need was identified (operational deployment, training exercise, experimentation, formal study, mission area analysis, observed operating deficiencies).

Since the beginning of the Global War on Terror (GWOT), CH-53E Super Stallions have been involved in one Class A mishap and six hard landings in which reduced visibility during landing was a likely contributor. Besides the enemy, the greatest threat to the CH-53E in the Iraqi Area of Operations (AO) comes from landings to unimproved zones during low light level conditions where loss of visual ground reference occurs at the end of an approach. The loss of visual ground reference occurs when visibility in the landing zone degrades due to the presence of dust, snow, fog, or smoke coupled with darkness. Current aircraft systems (GPS, HNVS, ANVIS/HUD) all aid the aircrew with arrival to the landing zone, but do not provide accurate cockpit indications of aircraft drift during the final phase of the approach which occurs in the last 25 feet. The loss of visual reference creates an emergency situation, which requires an immediate transition to a working instrument scan and ensuing wave off if ground reference is not reacquired. A system is needed to mitigate the risks associated with landing in unimproved zones during reduced visibility conditions where no visual ground reference exists. The system should allow the aircrew the capacity to land the aircraft vertically from a low altitude hover within NATOPS prescribed limits for rate of descent, static rollover, and dynamic rollover. Additionally, the system needs to be capable of a precision hover, at differing altitudes, to allow for the hook up and delivery of sling loads in unimproved landing zones day or night, in zero visibility conditions. The system should be integrated with the HNVS and ANVIS/HUD and provide symbology to the pilots in order to facilitate a safe zero visibility landing. A system that is integrated with the Automatic Flight Control System and capable of performing autopilot coupled approaches, would provide even greater risk mitigation in zero visibility conditions.

When Needed

URGENT		6 Months		1 Year	X	2 Years		5 Years		10 Years		Other (date)

Rationale
Describe why the need requires resolution in timeframe selected (e.g., safety issues, Congressional mandate, etc.)

In the Iraqi AO, the loss of visual ground reference during night landings to unimproved, dusty landing zones is the greatest safety risk to CH-53E aircrew, passengers and aircraft. Loss of visual ground reference during an attempted landing partially contributed to one CH-53E Class A aircraft mishap. The GWOT is going to continue and there will be a requirement for the capability to safely land CH-53E's in unimproved landing zones in conditions that may cause loss of visual reference due to dust, snow, fog, smoke or darkness.

CDTS Short Title	
CDTS#	Date CDTS # assigned

Describe mission or task to be accomplished that is related to the need.

CH-53E squadrons will be able to execute Assault Support missions for the Marine Expeditionary Force (MEF) Commander to all landing zones, day or night, in zero visibility conditions with a mitigated risk factor that is not currently available.

How does the need improve your ability to perform the mission or task?

The capabilities of a zero visibility approach system would reduce most of the risks associated with night dusty landings to unimproved landing zones, and release other MEF aircraft from the mission of Battlefield Illumination in support for CH-53E inserts to certain landing zones. Additionally, a zero visibility hover system would allow the CH-53E to conduct Helocast operations at night, and Tactical Recovery of Aircraft and Personnel missions at night over water. As a result, the MEF Commander will have the ability to project combat power and move cargo and supplies throughout his AO, to all types of zones during day or night conditions with negligible risk to personnel and aircraft.

If the need is not satisfied, how will it affect your ability to perform the mission or task?

The current Assault Support mission can still be accomplished but at a greater risk to aircrew, passengers and aircraft. There would be an additional requirement for MEF aircraft to provide Battlefield Illumination for certain landing zones in order to mitigate the risk associated with landings to low visibility landing zones during low light conditions.

Approval Authority – Regimental Level or as appropriate (Battalion, Squadron, etc.)

Office (symbol) MAG-11	Name of Approval Authority (Last, First, Initial) Stalnaker, James, L	Rank/Grade Col
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Approval Authority Comments (optional)

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Approval Authority – MEF Level or as appropriate (Division, Wing, Service Support Group, etc.)

COMMANDING GENERAL	Name of Approval Authority (Last, First, Initial) Helland, Samuel T	Rank/Grade MGen
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	E-mail Samuel.helland@usmc.mil	
	Date Received 27 FEB 06	Date Forwarded 3 MAR 06

Approval Authority Comments (optional)

Signature Block

NOTES:

1. Issues should be forwarded to CG MCCDC via respective chains of command.

Issues require one General Officer's signature (at any level i.e. MARFOR. MEF, Div/Wing/FSSG, etc.) to be processed. Issues must be forwarded through chains of command for MARFOR endorsement (as applicable). MARFOR

CDTS Short Title	
CDTS#	Date CDTS # assigned

Approval Authority – Regimental Level or as appropriate (Battalion, Squadron, etc.)

Command	Name of Approval Authority (Last, First, Initial)		Rank/Grade
Mailing Address	Phone	FAX	
	E-mail		
	Date Received	Date Forwarded	

Approval Authority Comments (optional)

Signature Block

Approval Authority – MEF Level or as appropriate (Division, Wing, Service Support Group, etc.)

Command	Name of Approval Authority (Last, First, Initial)	Rank/Grade
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	E-mail	
	Date Received	Date Forwarded

Approval Authority Comments (optional)

Signature Block

Approval Authority – MARFOR Level or as appropriate*

Command U. S. Marine Corps Forces, Pacific	Name of Approval Authority (Last, First, Initial) Goodman, John F.	Rank/Grade LtGen
Mailing Address Commander U. S. Marine Corps Forces, Pacific Box 64119 Camp H. M. Smith, HI 96861	Phone 808-477-8600	FAX
	E-mail goodmanjf@mfp.usmc.mil	
	Date Received 8 Mar 2006	Date Fwd'd to Assessment Br, MCCDC

Approval Authority Comments (optional)

General Officer's Signature Block

John F. Goodman

G5
20 March 06

DECISION PAPER

Subj: 3rd MAW CH-53E Landing Assistance System UNIVERSAL NEEDS STATEMENT (UNS)

Encl: (1) 3rd MAW CH-53E Landing Assistance System UNIVERSAL NEEDS STATEMENT (UNS) Package

1. PURPOSE. To obtain the Commander's validation decision on the subject STANDARD UNS.

2. BACKGROUND

a. 3rd MAW submitted a standard UNS (TAB 1) stating the need for a landing assistance system to facilitate landing in un-improved LZs. The enclosure states that such a system may have prevented a Class A mishap and helped to avoid six hard landings that CH-53Es have been involved in where reduced visibility was a factor.

b. MARFORPAC staffing has been completed.

3. DISCUSSION

a. The UNS was staffed with the G3 and ALD. Both divisions concluded that the UNS describes a valid requirement.

b. ALD contacted NAVAIR's CH-53E program office (PMA-261) and confirmed that they are not presently pursuing a landing assistance system for the helicopter.

4. CONCLUSION. The subject standard UNS describes a valid requirement.

5. RECOMMENDATION. That the Commander approve the subject standard UNS.

C. E. BLANCHARD
AC/S G5

Prepared by: LtCol Rowsey, G5 R&P, DSN 477-8782

APPENDIX C

Recommended T&R FLIR Syllabus

FLIR CAL –300 1.0 1 CH-53

Purpose. Develop landing skills in (emergency procedure) brown out or low visibility conditions utilizing FLIR
Hover symbology

Goal. Perform FLIR hover symbology operations

Requirement.
Discuss:
Aircrew Coordination/Responsibilities: to include standardized calls for drift/descent/observation, etc.
Confidence building
Loss of visual reference during landing
Power settling
Settling with power
Low altitude emergencies
High gross weight takeoffs/landings
FLIR hover calibration procedures
FLIR capabilities and limitations/malfunctions and degradations
Different modes and capabilities associated with MFDU functions/symboloby

Introduce:
Landings utilizing FLIR hover symbology

Review:
FLIR operations
Emergency Procedure: Loss of visual reference during landing

Performance and standards.

- Hover calibrating the FLIR. (Appendix A)

- Conduct 2 landings on the runway from a 10 foot hover utilizing the RADALT hold feature and the HVR/PSN queues on the FLIR

- Perform a NATOPS approach to a spot on the runway to arrive at a 10 foot hover and use the RADALT hold and HVR/PSN queues on the FLIR to make the final landing.

    - TRNS mode on FLIR activated between the 90 and rolling final (<60 KIG) speed
    - HVR mode activated when airspeed is below 5 KIG

- PSN mode activated when A/C is in a 10 foot hover (<5KIG)

- Transition to the dusty landing area LZ and PAC conduct 2 landings from a 10 foot hover utilizing the RADALT hold feature and the HVR/PSN queues on the FLIR and a NATOPS approach to a spot in the dusty area LZ to arrive at a 10 foot hover and use the RADALT hold and HVR/PSN queues on the FLIR to make the final landing

<u>Prerequisite</u>. CAL-161?

<u>Ordnance</u>. N/A

<u>External Syllabus Support</u>. None

FLIR Hover Symology Operations

WARNING

TRANSITIONING BACK AND FORTH BETWEEN THE SYMBOLOGY AND OUTSIDE, MAY DISTRACT THE PAC FROM ACTING ON THE VELOCITY VECTOR AND CAN RESULT IN UNRECOVERABLE DRIFT, AND OR UNINTENTIONAL CONTACT WITH THE GROUND/OBSTACLES. THE PURPOSE IS TO ARRIVE AT A 10 FOOT HOVER **NOT A LANDING**

CAUTION

Lack of hoge power may result in the inability to wave off and or clear obstacles during wayoff.

1. Technique:

   a. Terminate to a point in a 10 foot hover, then perform a hover landing.

2. Discussion:

   a. Landing an aircraft with loss of visual reference prior to touchdown has a higher degree of risk. Mitigate risk by correctly utilizing certain techniques and avoiding others. The overall goal of utilizing FLIR hover symbology in brown out or low visibility conditions are:

      - Allow the aircraft systems to work for you.
      - Prevent spatial disorientation by avoiding abrupt control inputs and pitch attitude changes while in a no visual reference condition.

   b. The crew must commit themselves to the FLIR hover symbology landing prior to losing visual reference. A successful landing is doubtful if the crew waits until being enveloped by a dust cloud to transition to instrument aided hover techniques.

3. Crew Actions:

   a. PAC remains focused inside the cockpit "head down." He directs PNAC to engage and select appropriate hover reference and altitude guidance cues as requested.

   b. PNAC selects hover functions as requested by PAC. PAC and Aircrew clear aircraft as required.

4. Procedures:

a. Systems integrity and setup

Prior to T/O PNAC press "HVR" Panel Display Unit (PDU) softkey.

- If Velocity Vector (VV) and aircraft remain within the center reference "cross hairs" with minimal drift, the system is operational.
- If VV skews off to a 45-degree angle the system is not hover calibrated. Proceed to hover calibrate the FLIR utilizing procedures in appendix A.

Note: If hover cal is unsuccessful do not attempt FLIR symbology landings.

b. Preset RADALT hold at 10 feet.

c. The procedure is performed in the same manner as a normal VMC NATOPS approach to arrive at the intended point of landing at a 25 foot hover and use the RADALT hold and HVR/PSN queues on the FLIR to make the final landing. (Use of the RADALT hold is optional)

Note
At altitudes less than 200 feet with the RADALT engaged, the rate of descent will not exceed 200 fpm.

- Between the 90 and rolling final, <60 knots indicated ground (KIG) speed PNAC select TRNS mode on FLIR
- PNAC select HVR mode when airspeed is below 5 KIG
- PNAC select PSN mode (and RADALT Hold if desired) when aircraft is in a stable 10 foot hover (<5KIG)

d. PAC announces attention is focused inside aircraft "head down" and makes transition to the hover symbology prior to entering obscuration, and in a timely manner to act upon displayed information. He will ensure aircraft stability during the terminal phase of the approach.

e. PAC announces he is in a stable hover on the hover symbology and announces his attention to land the A/C

f. PNAC and Aircrew confirm suitability of the area, assist in clearing the aircraft and provide adequate warning of excessive drift calls. Additionally, PNAC will announce radar altitude, and rate of descent. Aircrew will make final calls from the last 10 feet until "LANDING" is made.

Note

The FLIR does not give a good outside picture of terrain/obstacles when in a dusty zone and cannot be relied on for placement in a landing zone. It should be used for hover cues only.

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